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AGASSIZ AND THE SCHOOL AT PENIKESE[1]

IN establishing the Anderson School of Natural History, Agassiz transferred his methods of instruction from his brick and iron-girded museum in Cambridge to the wooden barn-like structure at Penikese. The work was to be based on observation and experiment. Animals alone were to be studied, and in every instance the animal was to be under the eye of the student; nowhere was a list of books suggested for reference or consultation, and recitations consisted in answering the questions asked by the teacher as to what the student had observed in his studies. As in the Cambridge Museum the student had set before him a long, shallow tin pan, and in it was placed a fish, crab, lobster or some other animal, alive or dead, alcoholic or dry, and he was required to study and dissect it. Scudder, the entomologist, gave an amusing account in *The Atlantic Monthly* of his initial experience as a student of Agassiz in Cambridge. His previous natural history studies had been almost exclusively confined to butterflies and after his experiences with these dry and charming creatures he had placed before him a big fish which he was required to haul out from a jar of alcohol which was charged with the odoriferous juices of many previous specimens. This bad smelling object he had to examine for three days and to tell Agassiz what he had seen. Among other results this method taught students to use their eyes, an art already acquired by Scudder in his previous study of insects.

Agassiz realized in opening this school what temptations would arise in living near the sea side, and in an early circular he suggests the stipulations he required of the students by saying, "I must make hard work a condition of continued connection with the school, and desire to impress it upon the applicants for admission that Penikese Island is not to be regarded as a summer resort and relaxation. I do not propose to give much instruction in matters which may be learned from books, I want, on the contrary, to prepare those who shall attend to *observe for themselves*. I would, therefore, advise all those who wish only to be taught natural history in the way it is generally taught, by recitation, to give up their intention of joining the school." This sound advice was

[1] Address at the celebration of the fiftieth anniversary of the founding of the school at Penikese, Wood's Hole, August 13, 1923.

generally followed, although at the outset three young men ventured to relieve their animal spirits, or to "cut up," under the plea that "boys will be boys," and were promptly requested to leave the island, which they did. Recreation at the proper time was allowed, however, and we all went in bathing or sauntered over the island. I recall very vividly the first Sunday of the term; it was gloomy to the last degree. It reminded one of Taine's definition of London on Sunday, "a huge but well-regulated cemetery." The students kept rigidly to their rooms. On the second Sunday I induced Professor Wilder and other teachers to join me in a game of croquet (tennis was unknown in this country at that time), and this example by the teachers changed the whole complexion of things and the students came out of their rooms and roamed over the island, or collected specimens along the shores. In the evening we all joined with the students in a singing fest out of doors. If I remember rightly, the songs we sung were the good old-fashioned hymn-tunes, and this performance satisfied the more religiously inclined.

Some of the teachers had brought their families with them, and my little boy, four years old, was fond of wandering through the laboratory and curiously examining the contents of the dissecting pans. At one table Miss White, a teacher from New Bedford, was studying the gross anatomy of a cat. The creature was eviscerated, and Miss White was hard at work on the body with her dissecting scissors and needles. The boy came along and looked over the disemboweled creature, and the teacher, expecting some exclamation of disgust, leaned back in her chair curious to know what observation the child would make. Finally after a critical examination of the remains and the dissecting implements, he turned to her and asked, "Miss White, are you trying to mend that kitten?" Certainly a most natural question, as the cat was evidently in need of extensive repairs.

Many of our students became professors of natural history in our colleges and universities. David Starr Jordan became president of the State University of Indiana and, afterwards, of the Leland Stanford, Jr. University of California; Charles O. Whitman became professor at the University of Chicago, and for years was the able director of this laboratory during its greatest period of emergency; William K. Brooks occupied the chair of zoology at Johns Hopkins University and Charles S. Minot became professor of embryology at the Harvard Medical School.

At Penikese, Whitman and I were engaged in the study of the Ascidian Perophora and on comparing our drawings of this animal I found that his drawings were better than mine and, remembering this fact several years after, I appointed him as my successor to the chair of zoology in the Imperial University of Tokyo, where he introduced section cutting, the staining of tissues, etc.; new methods which he had learned at the University of Leipsig under Leuckart.

It is interesting to observe that among a class of zoological students a number seem to absorb intuitively the salient points in every investigation, and others seem totally blind to the significance of what they study. Simple figures even escape their memory. I recall a story told of Professor Cleveland, of Bowdoin. He always showed irritation at the inattention of students, and in one of his lectures on chemistry he interrupted his discourse by peremptorily asking an inattentive boy, "How many elements did I say there were?" Of course the student did not remember a figure that he had probably heard a hundred times and nudged a student next to him who whispered "sixty-two," the number of elements then known. All he caught was "two" and this number he called out promptly and loudly. The professor gave him a contemptuous glance and resumed his lecture. The student realizing that the professor had been greatly annoyed went down to the platform after the lecture and in order to placate him asked him, "How poisonous did you say cyanide of potassium was?" The professor with much emphasis said, "I told you that cyanide of potassium was so poisonous that a drop on your tongue would kill a dog." Certain students attend courses of lectures and are utterly unable to carry away a single fact. Sir Michael Foster told me of an experience he had in a course of lectures before the Royal Institution on human anatomy, illustrated by diagrams and objects. At the end of his course, one of his auditors asked him whether the cerebellum was inside or outside of the skull! and he further added that Huxley had told him of a similar experience. He was also lecturing on human anatomy and at the close of one of his lectures an auditor came to the platform to ask him some question and noticing a human skull lying upside down on the table incidentally remarked, as he poked his finger into the foramen magnum, "Many a good chunk of bread and butter has gone through that hole!"

Naturalists are born, not made. Sir David Gill, the director of the Royal Observatory at the Cape of Good Hope, in a review of a memoir on "Double Star Observations," in speaking of the authors, said, "It is a special faculty, an inborn capacity, a delight in the exercise of exceptional acuteness of eyesight and natural dexterity, coupled with the gift of imagination as to the true meaning of what he observes, that imparts to the observer the requisite enthusiasm for double star observing." These words may truthfully apply to the work of the naturalist.

Agassiz fully imbued with the classification of

Cuvier emphasized the importance of the study of examples illustrating the four types of Cuvier and the students had in turn a radiate, a mollusk, an articulate and a vertebrate to dissect and study. He not only lectured on these subjects but gave to the school a course of brilliant lectures on the glacial theory. At this point I must emphasize the fact that Agassiz was a wonderful teacher. The charm of his manner and his speech, rich as Apollo's lute, as Governor Banks said at the dedication of the museum, with its slight foreign accent, enabled him to talk on radiates, for example, to a lot of hard-headed Massachusetts farmers at the General Court and secure appropriations of thousands of dollars for his museum at Cambridge. He strongly opposed Darwin's views, but few realized the leading cause which probably animated his strenuous opposition. In 1859 Longman published a separate volume of Agassiz entitled "An Essay on Classification," which had formed the introductory chapter to his "Contributions to the Natural History of the United States." In this essay he had insisted that classification was natural, that the various categories of classification—branch, class, order, family, genus and species were as distinctly created as the individual. Simultaneously with the appearance of this valuable essay appeared Darwin's immortal work on the "Origin of Species," in which it was shown that classification was artificial, not natural, that categories of structure were the results of slow and diverging modification—in other words, that natural selection and not special creation was the cause of all this diversity of animal life. De Candolle, the illustrious French botanist, when he became acquainted with Darwin's view remarked "That it was not a theory, nor an hypothesis, but the explanation of a necessary fact, to deny which would be to deny that a round stone would not roll down hill farther and faster than a flat one." However, Agassiz's essay with the unhesitating endorsement of the views of Von Baer unwittingly supplied the strongest material for Darwin's views and led Agassiz's students, one after the other, to embrace them.

Among the various accounts that were published about the Agassiz School at Penikese was one by David Starr Jordan in *The Popular Science Monthly*, 1892, Vol. XL. In this article, Dr. Jordan gives extracts from a journal which he kept when a student at Penikese, wherein he had recorded sentiments and expressions of Agassiz given in his lectures and comments to his class.

The distinguishing feature of the Anderson School of Natural History lies in the fact that it was the first one of its kind organized in the United States and furthermore that this initial experiment was under the direction of the greatest teacher of natural history in the world. Other schools of a similar nature under the auspices of colleges and universities sprang up in various parts of the country. I do not know the chronological sequence of these summer schools of natural history, but, if I mistake not, the Salem Summer School came next, in 1876. Among the teachers of this school were three who had been associated with Agassiz at Penikese—Packard, Putnam and the present writer. Of all the summer schools in the country the Marine Biological Laboratory easily comes first in the number of its instructors, buildings and equipment, and superadded to this foundation its proximity to the United States Fish Commission gives it unparalleled advantages over all other schools of this nature.

EDWARD S. MORSE

PHYSICS AS A CAREER[1]

IT is said of the famous Clerk Maxwell that throughout childhood he continually asked the questions, "What's the go of that? What does it do?" Vague answers did not satisfy him but aroused the more distinct demand, "But what's the *particular* go of it?" Maxwell had the opportunity of devoting a life to the answering of this question, many times repeated, and of rendering such service to mankind that he will be forever highly honored among those known for their important contributions to the field of physics. Do the incipient Maxwells of to-day have in America a similar opportunity? They do, but there is danger that this fact is either unknown to them or not known sufficiently early in life.

A boy does not know of a physicist in his community and the stories of achievement in physics which he may read refer to very distant realities. Moreover, so far as he is aware, physics is not a profession. As he surveys his known opportunities for a life-work, engineering may be the only profession that seems to have an interest in the "particular go" of things. The purpose of this article is to present briefly and with directness the opportunities in physics in our country to-day. It is assumed that, given the possibility of earning a livelihood, one will choose the career which most nearly satisfies his intellectual requirements. Since the aptitude for physics is usually distinct, a comparison of the profession of physics with others is thus unnecessary. The follow-

[1] This is one of a series of articles which are being published in SCIENCE and in *The Scientific Monthly* describing to young men and women in American colleges and universities who contemplate entering upon a professional scientific career the opportunities in various lines of scientific work. This series has been prepared at the suggestion of the Division of Educational Relations of the National Research Council.

ing statement is intended merely to give one who is already interested an assurance that there is an opportunity for the physicist which is limited only by his ability.

The chief avenues open to physicists are found in education, in industry and in government service. What is the prospect of a permanent demand for physicists in these fields? The number of teachers required for our colleges and universities has grown with the rapidly increasing number of students. From educators we learn that the demand for an increase in educational facilities is not occasioned by a temporary interest, but by a realization of the value of education and by a response accentuated through the adjustment of our educational institutions to the more obvious needs of the people. The growth of our educational institutions is therefore certain to continue to be rapid. The industries, particularly those interested in electricity, have grown with tremendous rapidity and have simultaneously expanded their research and development laboratories. The experience gained has demonstrated the constant necessity of improvement of products, of cheapness and of service. It is therefore reasonable to expect a continual increase in the facilities of these laboratories and in the number of physicists employed. The government laboratories have grown with similar rapidity. Thus, in every line of activity of the physicist there is an indication of a permanent demand. The profession of physics is established. A physicist may be a teacher only, he may combine teaching and research, he may devote himself to investigation, to development or to a combination of the two, or he may become an administrator in industry.

Teaching

Every college student is aware of the compensation in the life of a professor. He is not handsomely rewarded in money, but he lives simply. His family may be deprived of very expensive pleasures, but his children have opportunities for the development of brain and character that can scarcely be measured in terms of money. The real teacher enjoys thoroughly the opportunity of aiding in the development of the young that come into his classroom. He has a vision of helpfulness and of the indefinite extension of his influence through others. It is frequently the teacher in the college, perhaps an investigator in only a small way, who has the best opportunity to assist young men in finding the professions to which they are best adapted. Also, he is responsible in part for the important contributions to physics made by his former students. This is a part of his compensation.

Teaching and Research

In the large educational institutions the teacher is an investigator who may select for study whatever field he chooses. He receives no demands from his superiors for results that are of immediate practical importance. He is free to choose for investigation any problem that catches his interest and fires his imagination. His intellectual opportunities are without limiting boundaries, and his attainments are determined solely by his ability. Yet he has the satisfaction of serving also through his teaching, his contributions and his students who subsequently become productive physicists.

Research, Including Development

Upon industrial as well as purely scientific research depends the future development in the products of industry. So active has been the development of electrical applications that the opportunities for research physicists have increased rapidly. The example set by large industries in the employment of these physicists is being followed by others. In 1921, there were forty or more such laboratories employing physicists. The nature of the need of research may be illustrated by reference to the art of telephony. As perfect as the art is to-day, the increase in the congestion of business in our great centers and the demand for long distance communication, both telephone and telegraph, have necessitated improvements in transmission undreamed of a few decades ago. Yesterday, conversation between New York to San Francisco was a wonderful achievement. To-day it is common-place. The research laboratories have solved the problems in physics involved and the development engineers have adapted the solutions to practical service. But the research laboratories are interested not only in the problems pressing for immediate solution, but they must, so far as possible, foresee the demands of the future. While the research physicist in an industrial laboratory does not enjoy entire freedom in research, yet the desired applicability of his results supplies a challenge to his best powers and his success gives keen satisfaction. One must not gain the idea that the research laboratories are demanding merely experimental physicists. They employ also mathematical physicists who never experiment. In fact, it is appropriate here to say that every physicist must be a theorist. The subject has become so involved that he must usually depend upon mathematical reasoning to determine the plan and method of his experiments.

Government Service

The Bureau of Standards is now the greatest laboratory of standardization and allied research in the world. Its physicists are employed for the most part in testing for the various industries and educational institutions of the country. But, at the same time,

physicists have there been enabled to make some of the most distinguished of the recent contributions of America to physics. Other bureaus, for example, the Weather Bureau, also employ physicists.

ADMINISTRATION IN INDUSTRY

More and more is recognized the value of a scientific or technical training for men in administrative positions in industry. Some of these are in connection with research only, but others are in the business organization itself.

THE FINANCIAL COMPENSATION

If this brief article were to discuss the attractiveness of physics as a career, it would present the intellectual appeal as the most and the financial appeal as the least important. But it is assumed that the reader is already more or less aware of the nature of the various compensations enjoyed but needs especially to be informed as to the amount of salary that, at the present time, may be expected by an established physicist. In the colleges of recognized standing, the minimum salary of a professor for the college year of nine months is approximately $2,500. A few receive $2,000 or less; many receive more than $3,000. Of course, the scale of living in the community is as important a consideration as the salary itself; yet it is impracticable to introduce living costs into this presentation. In the large universities of the country, a similar position pays from $4,000 to $6,000, with exceptional higher salaries. In government service the salaries are practically the same as in education. In industry the highly trained physicist, if successful, may anticipate at the end of five or six years a salary of $5,000 or $6,000. There is no upper limit in industry for men either in research or in administration.

ABILITY

The desirable innate ability of a prospective physicist is not definitely known in detail and its measurement is even less certain. Comments thereon must hence be somewhat general. The special requirements for a successful teacher, a research worker, a development engineer and an executive in industry need not be described, as many of the differences are apparent to the student. But it is well to remark that a career in physics demands not only rigorous thinking but also that type of persistence and patience which is required in any worth-while endeavor. Of course, there is always a chance of an accidental scientific discovery of importance, but it is very much smaller than is commonly believed. It is a matter of interest that no physics research laboratory, industrial, governmental or educational, is organized to encourage especially accidental discoveries. Real contributions may arise through accident, but progress in research is usually by a procedure based upon deductions obtained through analysis. Moreover, the purely experimental physicist is vanishing with the increased complexity of the field, and a student who can not use mathematical methods will find therein an increased difficulty in attaining leadership in investigation in the years ahead. An aptitude for analysis, a noticeable mathematical ability, a deep interest in the "particular go of things" and a courage comparable to that in any profession are essential for the highest success.

PREPARATION

The preparation required depends upon the nature of the position. There is a demand for those with a college degree as well as for those who have pursued graduate work and have received the M.A., M.S. or the Ph.D. degree. Research and development require clearness of thought, a knowledge of the field and a confidence that comes through experience in intellectual effort. It is obvious that graduate study will develop these qualities and hence will increase the physicist's value. In education, most college and university positions demand the Ph.D. degree, though a number of minor colleges do not insist upon a preparation beyond the Master's degree. In industry the difference in preparation is recognized at the outset by a difference in salary. But it is in the long run that training shows its value. It may be said that the more ambitious a physicist the more concerned he should be to secure the best educational preparation possible. The nature of this preparation may be inferred from an earlier comment. The theories upon which researches are based are usually mathematical and the student who wishes the best chance for advancement in his career must emphasize mathematics as well as physics. If one is especially fond of mathematics he may well aspire to become a mathematical physicist. In such a case the mathematical training possible in the requirements for a Ph.D. in physics is not sufficient. There are a number of adequately equipped graduate departments of physics in this country and young men of ability will find available graduate appointments carrying stipends, but which involve no return in service, and graduate assistantships which give an opportunity for self-support. The former is to be preferred, for the combination of teaching and study found in the latter requires a longer period of preparation. The way to the top is not short and an ambitious young man needs to save all the time possible.

In general it is fair to say that high attainment as a physicist is difficult. It is in this difficulty, however, that the challenge and ultimately the joy in suc-

cess rest. If one goes into business to make money he will seek, if possible, an unlimited opportunity. If one enters upon an intellectual career he desires the opportunity to achieve the highest success of which he is mentally capable. He wishes to be limited by nothing save his own ability and industry. A physicist has just this opportunity. He need not wait for business to grow or clients to appear. He can study and contribute to the most important and fundamental problems in physics of the day. He can, if his researches are published, attain without difficulty nation-wide recognition for what he has accomplished. As a consequence he can not avoid chances of advancement appropriate to his ability. His light is upon a hill and can not be hid.

The purpose of this paper is to present to interested students facts without persuasive enthusiasm, and hence to attract to physics as a career only those whose ability and intellectual ambitions can turn a plain statement of facts into an appeal.

George Walter Stewart
University of Iowa

A COURSE IN GENERAL SCIENCE

It may be reasonably conjectured that at every university in the United States the elementary courses in science are overcrowded. Complaints take various forms: Instructors have no time for research; students can not be interested or even taken care of; weak but industrious students fail in large numbers.

Under the circumstances it might well seem that a possible remedy for the situation has been overlooked. Have we not made the teaching of the individual sciences too much of a fetich? Can not something be said for the giving of a course in general science?

Objections in quantity come to mind. But most of them reduce to one of three points. No instructor knows enough to teach a worthwhile course in science in all its major branches. If such a person were found, the chief values of science teaching would be lost in what would necessarily be a lecture course. In any event, one more "snap" would be added to a curriculum which at least theoretically opposes easy courses.

Yet one may doubt whether, if there were a demand for lecturers on general science, supply would not follow. The writer has found a considerable number of students drifting through non-scientific "majors," yet taking for diversion a creditable quantity of differing sciences. Certainly these students could not teach any one science, even in an institution of reputable high school grade. Very often they are only mildly attracted by the experimental side of the sciences. So much may be granted. But, incidentally, they are usually far more interesting talkers and writers than us professed and lettered scientists; they might develop into very effective teachers of general science, if there were any inducement.

Doubtless the first set of such teachers, if not those of a later date, would make gross errors. It is too early to pretend to know what should be included in a course in general science. Possibly it might have running through it the basic idea of explaining evolution in its many forms from the Rutherfordian theory of radioactivity to the development of man from *Pithecanthropus*. But suppose the worst. Suppose a man who taught general science, and who knew nothing to speak of about electrons and explained valence with utter disregard of the newer chemistry; who gave his students in astronomy and geology La Place instead of Moulton and Barrell; who did not know that the thallophytes are a very miscellaneous group of plants, lumped together because none of them are bryophytes, pteridophytes or spermatophytes; who—but finish the heinous list for yourself, if you are a physicist, biologist, etc. Under our present system there seem to be some *Sigma Ksis* who discourse well on benzene rings and think chromosomes are plants; who can bound every ore deposit in America and blithely call whales fishes. Isn't it possible we have out-Huxleyed Huxley in our desire to flee from Greek and Latin? Which is worse: To have, as we do have, groups of young scientists who are really only organic-chemists or statistical geneticists or other ists, or to have scientists with a trifle less of specialties and an ABC knowledge of the fields of their fellows?

Besides, the confessedly inferior knowledge of this hypothetical teacher of general science is meant only for that vast group of students who can be attracted to science as a study of the laws of astronomy, chemistry, physics, but who revolt from the laboratory notebook and the minutiae of topographic maps. One great benefit of the suggested course would be the freeing of the enthusiastic laboratory teacher from the incubus of indifferent students—though there is hope that a stimulating approach to modern "organized knowledge" would lead some of the indifferent to further purposeful experimental work. Just as the true laboratory teacher would be relieved and perhaps even be enabled to do research, so would the student genuinely interested in science from the outset find himself among a small group of congenials who would eschew the general course and elect, these chemistry, those botany, etc. Surely, too, since the present courses in elementary this or that could then move far more rapidly, the chemist could find time for botany, the economic geologist time for biology, the mineralogist time for astronomy.

One may doubt, moreover, whether "the chief values of science" would be any more lost than at present.

One new value would be gained. Were all the freshmen who now dawdle through chemistry, biology or botany to return to their villages with an inspiring idea of evolution, in a short time there would be no such specimens of *Titanotherium modernum* as W. J. Bryan. A number, even of the "flappers," would, I believe, come to see the fascination in learning of hydrogen stars, cathode rays, the great seed-bearing fern-like trees of the Carboniferous, etc. It is not the facts of science unrolled as that marvelous tapestry we call evolution that the freshmen revolt from. They revolt from chemical formulas, from stains, from botanical slides of algae—all meaningless to them. If we can interest them in chemistry only by chemistry spelling-matches, we are worse than the Arnoldites whom Huxley fought so valiantly.

Reduced to the last analysis, our own love for the scientific method[1] is, I think, our feeling that we can win truth only by "exact definition, by the nicest" manipulation of instruments, by, in short, driving from our habits of thinking and doing everything that is vague and slovenly. No one need marvel that we shudder at freshman modes of thought and manipulation. But in our *vast, overcrowded* classes, can we even faintly hope to make over those who are frankly disdainful of periodic tables and the minerals in monzonite porphyry, hope to make them think and act as our ideals urge us to think and act? I know a most conscientious teacher of chemistry whose students at the end of a year blithely lay reagent stoppers on desks anything but clean—if no one is looking. Who trusts fragile apparatus in the hands of the average student? If all the students were failed whose quiz papers are but "memory gems," how many seats would be vacant after the first quarter? Why do we use that empty label called the "condition grade"? In other words, does our great run of students ever come to define science as we define it? And, if we do not teach these students *respect* for the scientific method, why pretend to, when we might, let us hope, lead them to grasp the fundamentals of each of the sciences through a properly managed lecture course.

"A properly managed lecture course." Such a course need not be a "cinch." That is the blunt answer to the third objection. For one thing, the working of purposeful problems and individual visits to a "hall of experiments and specimens" might be required.

Some to whom I have talked would not oppose the idea of a course in general science, were each science given by its own specialist. Logically, such lecturing would imply the use of heads of departments. Of course, not many heads are of the type of the learned geologist who spends the first three weeks in his elementary geology in forcing students to pretend to recognize models of scalenohedrons and their ilk, because the peculiarly poor text-book he uses opens with crystallography; or of the type of the chemist who wished elementary chemistry to be elective and who, since his desire was overruled, revengefully makes the course a thing of terror. Yet it is very true that, save for striking exceptions, heads of departments do not like to be censured (or censored), and that each year they become more and more ill-fitted to reach the freshman mind. The teachers of a course in general science should be the target of much criticism, should be enthusiastic, and should, above all, be subject to removal upon well-grounded complaints from their students.

Perhaps, indeed, all professors should be subject to retention or fall with much more reference to student judgment than at present. Undoubtedly, teachers of general science should.

A. J. TIEJE

LOS ANGELES, CALIFORNIA

[1] One interesting phase of the entire question is raised by such facts as these: In a great trans-Mississippi university, geology is not allowed as a "laboratory science," though the usual laboratory work is an integral feature of the course. A thousand miles west, in another high-grade state university, students are given "science credit" for a year's work divided between physiography, climatology, and the geography of North America. The "laboratory" work, aside from slight field trips, consists of the arithmetical and graphical solution of problems, the looking up of names, etc.

SCIENTIFIC EVENTS

HERMANN M. BIGGS

DR. SIMON FLEXNER, chairman of the New York State Public Health Council, has made public a resolution adopted by the council at a recent meeting in New York in honor of the memory of the late Dr. Hermann M. Biggs, state commissioner of health and chairman of the Public Health Council from the time of its organization in 1914 until his death last June. Besides Dr. Flexner the other members of the council as at present constituted include Dr. Matthias Nicoll, Jr., state commissioner of health; Mr. Homer Folks, secretary of the State Charities Aid Association; Professor H. N. Ogden, of Cornell University; Dr. Jacob Goldberg, of Buffalo; Dr. T. Mitchell Prudden, of New York, and Dr. Stanton P. Hull, of Petersburg. The resolution follows:

The Public Health Council of the State of New York, at its first meeting after the death of its late chairman, Dr. Hermann M. Biggs, desires to spread upon its records the following minute:

The relations between the Public Health Council of the State of New York and Dr. Biggs were somewhat

different from those existing between Dr. Biggs and the many other organizations of which he was a member. It was Dr. Biggs who first suggested the establishment of this council. It was his clear vision of the desirability of separating administrative from legislative duties in the field of health, and of placing the latter in the hands of a group, which led the legislature and executive of this state, in 1913, in the revision of the public health law, to create the Public Health Council, and to endow it with quasi-legislative authority.

Dr. Biggs was chairman of the council from its organization until his death. While his official position and his exceptional experience gave him at all times a very great influence in the council, he always sought the consensus of opinion of the council on all important matters of policy. The development of a sanitary code, dealing with matters which the staff of the department and its local representatives were able to manage administratively, has been the chief duty of the council. Not infrequently, however, at council meetings, all routine matters were brushed aside by the commissioner, in order to bring forward some proposed policy or action on which he desired the advice of the council. It is indicative of Dr. Biggs' wise caution that before action he sought to clarify his own judgment and opinions in the light of group discussion.

To every member of the council it has been one of the most interesting and gratifying experiences of life to observe the consistent and continuous development of the policy and the organization of the State of New York in public health under Dr. Biggs' direction. His plans were always far-sighted and comprehensive, but he was always ready to take, at any time, those steps which might then be practicable. If further advances were blocked in one direction, he sought opportunities of moving forward in other directions. Thus, step by step, we have been privileged to witness the development of one of the most important branches of the state government from relatively small beginnings into one of the most complete and effective of public health organizations. The council feels itself unable to indicate in any adequate way the loss to the people of this state which is involved in the death of Dr. Biggs.

His personal qualities, his patience, his soundness of judgment, his unerring estimate of public opinion, his skill in the selection of assistants, and in securing from them their loyal support and the best work of which they were capable, these, as also his many other exceptional gifts, were universally recognized.

The council deplores the death of Dr. Biggs and inspired by his work pledges itself to renewed devotion to the cause for which he labored so fruitfully.

THE DEANSHIP OF THE COLLEGE OF AGRICULTURE OF THE UNIVERSITY OF ARKANSAS

THE agricultural interests of Arkansas are deeply concerned in the choice of the new dean of the College of Agriculture of the University of Arkansas. The entire faculty of that college has addressed to President J. C. Futrall the following letter on the subject:

In view of the fact that the success of the College of Agriculture in its several branches, namely, teaching, station and extension work, and that the working conditions surrounding the members of the staff are in very great measure dependent upon the actions and policies of the dean and director, we trust that we may, without impropriety, set before you our views concerning the type of man that should be appointed to this position:

As director of the teaching in the college, he should be thoroughly familiar with the modern trend of education in agricultural colleges.

As head of the agricultural extension forces, he should be a man who has a grasp of the problems peculiar to that branch of service.

In our judgment, since the Agricultural Experiment Station is the branch of the work that must continually vitalize and enrich all the others, the dean and director should be a man who, through first-hand experience, understands the methods and purposes of modern agricultural experiment.

It is, therefore, highly desirable that the dean and director should have had recent experience in an agricultural college and experiment station lines of activity that have brought him into intimate contact with the problems of such an institution.

While we believe it is desirable to appoint a dean as soon as may be, yet we feel strongly that wise discretion should not be sacrificed to haste in this important matter.

We respectfully request that these suggestions be seriously considered, and that they be transmitted to the board of trustees of the university.

THE SCIENTIFIC EXHIBITION AT THE BRITISH ASSOCIATION MEETING

THERE is printed in *Nature* an article by Mr. M. A. Giblett on the scientific exhibition at Liverpool in which he says:

The ninety-first annual meeting of the British Association, which has just drawn to a close at Liverpool, was characterized by a new and important departure in the form of an exhibition of scientific apparatus, instruments and diagrams. The exhibition was on the lines of that organized each year in London by the Physical and Optical Societies, which is so effective in bringing together the users and makers of physical apparatus, but its scope was naturally wider, and many branches of pure and applied science were represented.

In opening the exhibition on Monday, September 10, Sir Charles Sherrington commented upon the comprehensive and representative character of the exhibits, remarking that it was very appropriate that such a collection should be brought together, and that this—the first of its kind—constituted a definite

development in the history of the British Association. He further referred to the remarkable advances in the making of scientific instruments during the last three hundred years, to the ever-growing importance of instrumentation, and to the unavoidable complexity of the apparatus needed for some of the simplest and therefore the most fundamental of scientific inquiries.

Admission to the exhibition was not confined to members of the British Association, to whom it was free, but the doors were opened to any member of the public on payment of the moderate sum of one shilling for one day only, while three times that amount guaranteed admission at any time during the fortnight of the exhibition. The results for the first week show that this arrangement was happily inspired, and that the exhibition was as popular with the outside public as with members of the association. The number of daily tickets sold was quite naturally largely in excess of the number of season tickets, but the demand for the latter was quite sufficient to justify their issue.

The exhibition committee was fortunate indeed in having at its disposal the excellent accommodation afforded by the Central Technical Schools, Byrom Street, and the exhibits occupied the rooms on three floors of this magnificent building. The fine lecture hall enabled daily lectures, in some cases illustrated by cinematograph films or experiments, to be given by men of science, a feature which contributed in no small degree to the success of the exhibition. The popularity of these lectures is sufficiently illustrated by the fact that arrangements were made for two at least to be delivered a second time—"The Optophone," by Professor Barr, and "Researches in Special Steels," by Mr. S. A. Main (Research Department of Sir Robert Hadfield's, Ltd.). Other lectures included "Ripples," by Professor L. R. Wilberforce; "Research and Industry," by Sir Frank Heath; "Experiments on Coal Dust Explosions in Mines," by Professor H. B. Dixon; "The Compass in Navigation," by Captain Creagh-Osborne, R.N.; "Flame," by Professor A. Smithells; "Kodachrome Cinematograph," by Dr. Mees (Kodak Co., London); "Developments in Wireless Telegraphy," by Commander Slee (Marconi Co., London).

CANADA'S BUFFALO HERD

So successful have been Canada's efforts to save the buffalo from extinction that it has been found necessary, in order not to overcrowd the ranges in the great park at Wainwright, Alberta, to dispose of about 2,000 animals. Sixteen years ago it was the general opinion of naturalists and others that the buffalo was doomed to follow the passenger pigeon and the great auk into oblivion. However, the Dominion Government, through the Department of the Interior, grasped the opportunity to secure a herd of 716 animals, and had them placed in Buffalo Park at Wainwright. To-day the greatest tribute to the government's foresight is the immense herd of 8,300 animals in the reserve; and the increase of these animals when protected and allowed to roam freely over a part of their old habitat has set at rest the fears as to their possible extinction and indicates a possible line of industrial development.

Notwithstanding the number taken from the herd from year to year to supply specimens to other parks in Canada, the United States, Great Britain and other parts of the Empire, it was found that some other disposition must be made of a large number in order that the park might not become overcrowded. Hence the decision, indicated above, to kill two thousand animals, surplus to the requirements of the herd.

All arrangements have been completed for the killing which will be conducted by experienced men under the supervision of government officials and carried out with expedition and the employment of humane methods which will also insure the best economic results. Experiments have been made in every phase of the work and the plans incorporate the most modern methods in connection therewith.

In Buffalo Park certain ranges are retained as winter quarters, where grazing is not permitted in the summer months, in order that ample forage may be provided for the cold season. When the time comes for the migration to the winter quarters this fall the animals which are to be killed will be kept in the main enclosure and not allowed to enter the reserved areas with the main body of the herd. Riders will herd the selected animals and drive them near the buildings where the dressing is to be done. The buffalo will then be quickly dispatched by expert marksmen using powerful rifles, this being the most humane method of dealing with animals of such size and strength.

The autumn has been selected for the killing since atmospheric conditions at this season are more favorable for the handling and preservation of the meat, and also because at this time the buffalo is in prime condition, that is, in good flesh and with an excellent coat ready to resist the severities of the winter.

The contract for the slaughter calls for the preservation of the hides and heads, which will be prepared for market as they can best be utilized. Robes, garments and novelties can be manufactured from the hides, while the mounted heads provide an ornament much in demand. The sum thus secured will be used to help to meet the cost of maintaining the herd, and it is hoped that it is but the beginning of a revenue of considerable proportions from this source.

THE CRUDE RUBBER SURVEY

THE Crude Rubber Survey authorized by the last Congress and undertaken by the Department of Commerce is now under way in every region where preliminary investigations were originally planned. Announcements have previously been made regarding the departure of individual parties to the British and Dutch possessions in the Middle East, to Brazil, and to other parts of Latin America; and the sailing of the investigating party for the Philippine Islands on September 11, marked the completion of the necessary preliminary work of the investigation.

Dr. H. N. Whitford, of the Yale University School of Forestry, who has had experience in conducting investigations of a similar character in Latin America, the Philippine Islands and the Far East, is chief of the Crude Rubber Section of the Rubber Division, from which the survey is being directed. Dr. Whitford is being assisted in the work by J. J. Blandin, who was for several years and until recently, general manager of the Sumatra Plantations of the Goodyear Tire and Rubber Company.

The field survey is being conducted by four parties of investigators, operating in the four major rubber growing regions; namely, the Amazon region, the Middle East, the Caribbean region, and the Philippine Islands. In all, there are over fifteen political units now being covered by the investigators, all of which territories are known to be potential fields for the cultivation of the *Hevea brasiliensis*, commonly known as the Para rubber tree.

The personnel of the expeditions now investigating rubber conditions in the various regions are as follows:

Dr. William L. Schurz, United States commercial attaché to Brazil, has charge of the Amazon party, assisted by Mr. O. D. Hargis, a rubber plantation expert of considerable experience in the Middle East, until recently manager of the Sumatra Estates of the Continental Rubber Company; Dr. C. F. Marbut, chief of the Division of Soils, Department of Agriculture; A. O. Pierro and E. R. Bjorklund, of the Department of Commerce, as secretarial assistants. Four experts from the Department of Agriculture, headed by Dr. Carl D. LaRue, a botanist experienced with the Hevea rubber and its cultivation in the Middle East, are cooperating with this party. The Brazilian party left Para on August 13, *en route* for Manaos, the Beni and Acre territories and Iquitos, prior to making surveys along the tributaries of the Amazon. The party is receiving the utmost cooperation from the Brazilian Government, which has placed at their disposal a river steamer and extended many other courtesies. The Peruvian, Ecuadorean and Bolivian Governments also offer practical assistance when the party enters their respective countries.

In the Middle East, Mr. David M. Figart, special agent of the Department of Commerce, who is well known in far eastern rubber circles, is making a very extensive survey of the existing plantation areas and costs. He is accompanied by J. W. VanderLaan, of the Department of Commerce, as secretarial assistant. Mr. Figart was for several years with the United States Rubber Company in charge of their Middle East Statistical Department.

The investigation in the Caribbean countries, including Mexico and the northern portions of Venezuela and Colombia, is in the hands of a party headed by Mr. John C. Treadwell, a practical crude rubber expert, and until recently Vice-President of the Continental Rubber Company of New York. He is assisted by H. H. Bennett, soil expert of the Department of Agriculture, and C. R. Hill, of the Department of Commerce, as secretarial assistant. Mr. Carlton Jackson, trade commissioner of the Department of Commerce, is making a supplementary investigation of the Maracaibo region of Venezuela. Mr. Treadwell's party is at present in the Republic of Panama, and will shortly undertake further investigations in the other Central American countries and Colombia up the Atrato River.

The personnel of the field expedition to investigate the rubber possibilities of the Philippines, includes Mr. C. F. Vance, in charge of the party; Mr. Alex H. Muzzall, recently connected with the Goodyear Plantations in Sumatra; Mr. John P. Bushnell, assistant trade commissioner of the Department of Commerce, and Mr. Mark Baldwin, soil expert of the Department of Agriculture. Mr. Vance has had previous experience in the Philippines and is thoroughly conversant with the early plantation development in the islands. The party sailed for Manila on September 11. Mr. W. M. Noble, a crude rubber expert of the Firestone Tire and Rubber Co., who had been expected to assist in the Philippine investigation, was unable to accompany the party, but will later be connected with the work in Washington.

In providing the personnel and in the assembling of data the department is enjoying the full cooperation of every important American rubber firm; those which at present own rubber plantations have even made their private records freely available upon request. The Rubber Association of America, Inc., and the National Automobile Chamber of Commerce have appointed advisory committees to assist whenever possible.

The Department of Commerce has selected men qualified by training and practical experience to understand and give consideration to all the various factors bearing upon the economic production of crude rubber and to push the investigation to a successful conclusion. It is believed that the data and information

gathered will be a definite and valuable contribution to the American rubber industry, and thus indirectly to the millions of Americans who use manufactured rubber products in one form or another.

After the return of the various parties to Washington, their separate findings will be assembled in the form of a complete report, which will be made available to interested firms and individuals at the earliest possible moment.

H. N. WHITFORD

SCIENTIFIC NOTES AND NEWS

IT is proposed that the bicentenary of the death of Newton in 1927 shall be marked by the publication of a new edition of his collected works.

MAJOR HENRY J. NICHOLS, Medical Corps of the Army, has been appointed director of the laboratories of the Army Medical School, Washington, D. C. The new building at the Walter Reed Hospital Reservation will be occupied this autumn.

PROFESSOR W. J. V. OSTERHOUT, of Harvard University, has been elected an honorary fellow of the Botanical Society of Edinburgh.

DR. EDWIN PETERSON, lieutenant in the Medical Corps of the U. S. Navy, has been awarded the Duncan medal of the London (England) School of Tropical Medicine.

SIR ARNOLD THEILER, director of veterinary research, South Africa, and Professor Charles Porcher, of Lyons (France), the British and French delegates to the American Veterinary Medical Association convention, recently held at Montreal, have been made honorary members of the association.

DR. ALBRECHT KOSSEL, physiologist of the University of Heidelberg, celebrated on September 16 his seventieth birthday.

DR. J. ENRIQUE ZANETTI, assistant professor of chemistry at Columbia University, and this year chairman of the division of chemistry and chemical technology of the National Research Council, has been made a member of a committee appointed by the League of Nations to investigate chemical warfare.

A TESTIMONIAL dinner was given to Dr. William A. Pusey, president-elect of the American Medical Association, at the first meeting of the year of the North Side Branch of the Chicago Medical Society on October 3. Dr. Pusey gave an illustrated lecture on "A study of the wilderness road to Kentucky—A doctor's diversion."

AT the seventy-first annual meeting of the American Pharmaceutical Association, Henry V. Arny, Ph.D., New York, was elected president for the ensuing year. The Ebert prize, in memory of the late Albert E. Ebert, of Chicago, was awarded to Paul S. Pittenger, Philadelphia, for his paper on "Biological standards of local anesthetics." The following grants were made from the research fund of the association for the year 1923–24: To E. Kremers and K. H. Rang, of the University of Wisconsin, for work on decolorized tincture of iodine and on such other preparations of the National Formulary as time permits—$250; to W. J. McGill, of the University of Michigan, for work on the electrometric titration of alkaloids—$200. These research grants are made annually from the interest accruing from the A.Ph.A. Research Fund, which represents the profits from the sale of the National Formulary.

ELLIOTT S. ROBINSON has been appointed assistant director of the Division of Biologic Laboratories of the Massachusetts State Department of Public Health.

EARLE G. LINSLEY, professor of astronomy in Mills College, Oakland, has been appointed director of the Chabot Observatory to succeed the late Charles Burckhalter.

DR. HAL DOWNEY, professor of histology, department of animal biology, the University of Minnesota, has been appointed American editor of *Folia Haematologica*, an international journal devoted to clinical and morphological hematology. American investigators in this field are urged to send in reprints of their papers for abstracting and original manuscripts for publication.

HERBERT L. J. HALLER, associate chemist, who has been on the staff of the Bureau of Chemistry since 1919 assigned to the Color Laboratory, has resigned to accept a position with the Rockefeller Institute for Medical Research.

DR. J. B. BROWN, formerly associated with Professor Alfred N. Richards in pharmacological research at the University of Pennsylvania, has joined the research staff of Swift & Co., in Chicago.

S. HENRY AYERS, formerly bacteriologist of the dairy division of the Bureau of Animal Industry, Washington, D. C., has been appointed director of research of the Glass Container Association.

V. H. WALLINGFORD, who recently returned from a year's study and travel as a fellow of the Commission for Relief of the Belgium Educational Foundation, has accepted a position as research chemist with the Mallinckrodt Chemical Works, St. Louis, Mo.

THE tuberculosis research fellowship maintained by the Hennepin County Tuberculosis Association at the Graduate School of Medicine of the University of Minnesota, Minneapolis, has been awarded to Frederick Eberson, Ph.D., formerly research bacteriolo-

gist for the Manchuria Plague Service, China, and associate in the research department of the Mayo Clinic, Rochester.

H. A. KUHN, who has been chief of the department of toxicology of the Chemical Warfare Service for the past four years, has been detailed to the University of Wisconsin for a year for a special course in toxicology under Professor A. S. Loevenhart.

PROFESSOR WILLIAM J. HUSSEY, director of the Detroit Observatory, University of Michigan, sailed from New York for South Africa on October 4. Professor Hussey will spend several months studying weather and sky conditions, especially in the Transvaal and Orange Free State, in search of a site for the Lamont 27-inch refractor, which is nearing completion at Ann Arbor. The equipment of the present exploring expedition includes a 12-inch refractor. Professor Ralph H. Curtiss is in charge of the Detroit Observatory, during Professor Hussey's absence.

As a result of the recent elections of the American Society of Mechanical Engineers the following officers have been chosen: *President,* Fred R. Low, New York, N. Y.; *Vice-Presidents,* H. Birchard Taylor, Philadelphia, Pa.; George I. Rockwood, Worcester, Mass.; W. J. Sando, Milwaukee, Wis.; *Managers,* E. O. Eastwood, Seattle, Wash.; E. R. Fish, St. Louis, Mo.; F. A. Scott, Cleveland, Ohio. *Treasurer,* Wm. H. Wiley. *Delegates to American Engineering Council,* F. K. Copeland, Chicago, Ill.; J. T. Faig, Cincinnati, Ohio; R. E. Flanders, Springfield, Vt.; Dexter S. Kimball, Ithaca, N. Y.; W. B. Powell, Buffalo, N. Y.; Wm. Schwanhausser, New York, N. Y.; S. W. Stratton, Cambridge, Mass.; C. C. Thomas, Los Angeles, Calif.; P. F. Walker, Lawrence, Kan.

DR. ALEXANDER WETMORE, of the Biological Survey, U. S. Department of Agriculture, has returned from Hawaii, where he has had direction of an expedition organized by the Biological Survey and the Bishop Museum of Honolulu, in cooperation with the U. S. Navy, to carry out a general scientific survey of the chain of small islands extending northwestward from Niihau to Midway and Ocean Islands. In addition the party visited Johnston and Wake Islands during July and early August. Reports on the extensive collections made will be published, when completed, in the bulletin series issued by the Bishop Museum.

PROFESSOR ARCHIBALD HENDERSON, of the University of North Carolina, has a year's leave of absence on full pay from the Kenan Research Foundation. He sails for England on October 17 and will spend the year in research work on relativity in the Universities of Cambridge, Berlin, Rome and Paris.

P. A. TETRAULT, assistant professor of bacteriology at Purdue University, has been granted a year's leave of absence to do research work at the Pasteur Institute.

DR. EDWARD W. WASHBURN, of the National Research Council, has returned from Europe and will resume active charge of the compilation of Tables of Physical Constants.

DR. KARL IMHOFF, in charge of the sanitary district of the Ruhr section of Germany, has been in the United States inspecting sewage disposal plants.

DR. W. W. LEPESCHKIN, the Russian plant physiologist, has been invited by the Plant Physiological Section of the Botanical Society of America to give a series of lectures in this country at various universities and at the annual meeting with the American Association for the Advancement of Science at Cincinnati. Dr. Lepeschkin will arrive in New York about October 15.

THE Cutter lecture on preventive medicine will be delivered by Sir Arnold Theiler, director of veterinary education and research, Union of South Africa, and professor of animal pathology in the University of South Africa, on October 17 at the Harvard Medical School. The subject will be "Phosphorus Deficiency in Animals: Its Effects and Prevention."

PROFESSOR E. V. MCCOLLUM, of the Johns Hopkins University, delivered an address on animal nutrition before the Science Club at Kansas State Agricultural College on September 20.

THE Rochester and Syracuse Sections of the American Chemical Society held a joint meeting at the New York State Agricultural Experiment Station at Geneva on the afternoon of September 29. The formal session of the meeting was devoted to a paper by Dr. D. D. Van Slyke, of the Rockefeller Institute for Medical Research, on "Factors influencing the distribution of electrolytes and water in blood." Dr. Van Slyke returned recently from China, where he organized the research work in biological chemistry at the Union Medical College at Peking. Dr. Dwight C. Carpenter, of the station staff, was in charge of the program.

SIR HUMPHRY ROLLESTON, K.C.B., president of the Royal College of Physicians of London, delivered the inaugural address at the opening of the London School of Medicine for Women on October 1. The subject of his address was the problem of success for medical women.

A WILLIAM FARR lecture, on the measurement of progress in public health, was given by Sir Arthur Newsholme on October 4 at the London School of Economics and Political Science.

DR. A. BIEDL, professor of experimental pathology

at the University of Prague, will deliver the first Harvey Society lecture at the New York Academy of Medicine on Saturday evening, October 13. His subject will be "Organotherapy."

CHARLES BURCKHALTER, astronomer and meteorologist, director of the Chabot Observatory, died in Oakland, California, on September 20, after thirty-eight years of service in connection with that institution.

PROFESSOR FREDERICK PUTNAM SPALDING, of the School of Engineering of the University of Missouri, died on September 4, aged sixty-six years.

DR. STEPHAN VON APATHY, professor of zoology at the University of Kolosvár, who was well known for investigations on neuro-histology, recently died at the age of sixty years.

THE International Horticultural Congress opened at Amsterdam on September 18. Papers were read on various subjects, including horticultural and plant diseases and the development of the dahlia.

UNIVERSITY AND EDUCATIONAL NOTES

THE new building of the Department of Chemistry of the University of Missouri is nearing completion. This building is the third building on the campus to be devoted entirely to chemistry. There will be an auditorium seating 175 students, and laboratory space for 600 students. There are five small research laboratories for instructors, besides administration offices and storerooms. The attic has been finished off into four rooms and will probably be used as research laboratories for graduate students.

A SOCIETY of Bologna has founded an endowment representing a stipend of 6,000 francs a year for an Italian student of physics and chemistry who desires to do research work in the Curie Laboratory, Paris. The fellowship is endowed for ten years.

DR. GEORGE W. MARTIN, of Rutgers College, has accepted an appointment in the University of Iowa, where he will be in charge of the work in mycology.

OSCAR E. HARDER, Ph.D. (Ill.), who has been in charge of the department of metallography in the School of Mines of the University of Minnesota, since 1919, has been given a full professorship. Mr. L. J. Weber, B.S., Ch.E. (Minn.), has been appointed instructor to take the place of Mr. C. M. Reasoner who resigned to become combustion engineer for the Pillsbury Flour Mills.

DR. WILLIAM LLOYD AYCOCK, Burlington, connected with the research department of the Vermont State Board of Health, has been appointed associate professor of preventive medicine and hygiene in the Harvard Medical School.

DISCUSSION AND CORRESPONDENCE

THE STRUCTURE AND ORIGIN OF COKING COALS

OBVIOUSLY, the logical method of discovering the structural features of coals which, on heating, become coke, is the investigation of thin sections. The best coking coals are, however, very difficult of manipulation, even by the improved methods devised by the present writer. After repeated efforts, success has been reached in the case of the well-known coking coals of the highest grade from the Pocahontas basin and the Connelsville field. In thin sections of these it is possible to determine the presence of quantities of charred wood and of structureless materials derived beyond any reasonable doubt from wood which has lost its organization in the process of transformation into coal. The spores which are so commonly present in bituminous coals from all parts of the world are conspicuous by their absence in coking coals of high rank. It is accordingly highly probable that coking coals as such are of purely woody origin, since they show no evidence of the presence of spores or any considerable amount of the dark matrix characteristic of cannels and oil shales. The hypothesis of the presence of "gelosic" or "algal" material is thus definitely negatived.

The investigation of more recent coals than those of Connelsville or Pocahontas is of interest in this connection. It has been found in certain instances that pure lignite, that is, coal-like substance which is entirely woody, is capable of giving rise to quite typical coke. This has been observed to be the case with lignites, both from the Mesozoic and Modern periods. Obviously, such lignites, representing as they do the modified wood of single trees, leave no chance for misinterpretation. Obviously, the various hypothetical substances which have been supposed to make coals capable of coking are by the very origin of the material excluded. It is interesting to note that coke, which has so completely replaced charcoal in the technique of modern metallurgy, is like charcoal derived from wood. Not all lignitic woods, however, are capable of being coked, and in fact, quite generally in brown coals, they do not possess that capacity. This condition arises out of the fact that the wood in brown coals has in general not undergone the right degree of chemical modification for the product to be a coking coal.

It is important in this connection to emphasize that cannels and oil shales, as such, are incapable of coking, and this conduct in the oven is explained by the fact that they are characteristically composed of a dark matrix and of spores, with a greater or less, but always proportionately small, amount of wood. Since the view has been put forward in many quarters that oil shales are composed of Algae, their conduct, when

subjected to dry distillation, definitely negatives the hypothesis of the presence of so-called "gelosic" substances in coking coals.

It will be clear to the reader from the statements made above that the best coking coals are purely woody in their origin. Coking coals of less value for metallurgical purposes may contain a greater or less amount of spore material, and their grade depends on the proportion of such material. From the large amount of charred wood scattered throughout the structure of Pocahontas and Connelsville coals, it may be reasonably inferred that they represent transport material laid down in open water, and in this respect are similar to other bituminous coals in their mode of origin.

E. C. JEFFREY

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SEEDS OR TUBERS OF AQUATIC PLANTS

DR. HUGO GLUCK, of Heidelberg, Germany, the authority on aquatic plants, appealed to the writer last year for help in securing seeds or tubers of certain native American aquatics in order that he might pursue his studies and complete the monumental work on which he is now engaged.

The writer was able last fall to secure for Dr. Glück only a few seeds and tubers, and hopes through this announcement to reach a wider circle of collectors and others who may have an opportunity to collect seeds and tubers of aquatics, and who may be willing to assist Dr. Glück in this way. The writer will be glad to send to any one interested a copy of the list of species which Dr. Glück desires and to forward any material that may be sent in for him.

A. J. PIETERS

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THE STIMULATION OF GASTRIC SECRETION BY HISTAMINE

IN 1920, Keeton, Koch and Luckhardt[1] demonstrated that gastric secretion of Pavlov pouch animals was stimulated by the subcutaneous injection of from 0.5 to 1.0 mg of histamine. Matheson and Ammon[2] have recently confirmed the above findings for man.

In the course of our studies on the genesis of the chemical secretion of gastric juice, we have made observations on the effect of histamine administered via the gastro-intestinal tract.

Our first observations were made on dogs having a Pavlov pouch and a Thiery fistula of the duodenum and jejunum; so that various substances could be applied to the mucosa of the intestine and their effect on the secretion of gastric juice be ascertained. When 100 cubic centimeters of 1 to 1,000 solution of histamine was applied continuously for 20 or 30 minutes to the mucosa of the Thiery fistula, as much secretion of the Pavlov pouch occurred during the hour following the application as was observed to occur in our animals during the second or third hours after the ingestion of a test meal of meat. We next administered to Pavlov pouch dogs by means of stomach tube doses of histamine varying from 50 to 150 mg dissolved in twenty cubic centimeters of water. We observed that 50 mg was just sufficient to provoke a secretion of gastric juice from the Pavlov pouch, while 150 mg provoked a secretion quantitatively and qualitatively equivalent to that excited by a meal of meat.

Such doses of histamine when administered by the gastro-intestinal tract, although comparatively very large, produce no toxic symptoms, as judged from the behavior of the animal.

When 200 mg of histamine are administered by stomach tube to man (only one man has been experimented on up to date), a definite stimulation of gastric secretion results and no symptoms are experienced.

We believe that these observations very probably have a direct bearing on the problem of the chemical secretion of gastric juice, since Koessler and Hanke[3] have recently reported that histidine is decarboxylated almost consistently in the intestinal tract to histamine, which is normally present in the intestinal tract of man.

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[1] Keeton, Koch and Luckhardt: *Am. Journ. Physiol.*, 1920, li, 454.

[2] Matheson and Ammon: *Lancet*, 1923, i (cciv), 482.

MEDICAL LICENSURE OF NON-MEDICAL DOCTORS

To the Editor of SCIENCE:

It is possible that my timely warning to non-medical doctors and other parties at interest (SCIENCE, August 3) may be deprived of some of its force by Dr. Woodward's subsequent objections to it (SCIENCE, September 14), if nothing further is written about the matter. He has made a mistake in calling the warning, "an attack on the medical profession." He would not have asserted, as he has, that certain papers appearing July 7 and July 14 were available to me, had he known that my manuscript was in your hands April 22. His fear that your readers were misled by my signature is not well founded; your readers know

[3] Koessler and Hanke: *Journ. A. M. A.*, 1923, lxxx, 1728.

that national societies address their own members through their own journals.

In so far as my note on medical licensure of non-medical doctors offends the medical profession, it does so because the facts therein set forth are *per se* offensive. That is incidental. It was an important object I had in mind. That object was to warn the non-medical doctors and other parties at interest in all of the States to watch their legislatures. This warning will bear repetition.

No one can deny the existence of House Bill No. 348, upon which my warning rests. No one who is informed can deny that this bill was backed by certain groups of physicians. No one can deny what the wording of the bill meant. Some of us discussed this with lawyers and also entered into conference with physicians here in Philadelphia. In these conferences it was found impossible to get the physicians to agree to a re-wording that would be mutually satisfactory. When the physicians who were conferring upon the bill here in Philadelphia finally (at a conference I attended) passed a motion to drop the bill, it appears that the physicians in Pittsburgh who were similarly interested in the bill refused to drop the bill. The bill had to be "killed in Committee" (in the House of Representatives). Possibly no one who read my paper knew that the effective quotations were from the pen of the physician who acted as chairman at the conferences I know about in Philadelphia and who spent time upon the re-wording of the bill itself. Had Dr. Woodward known this he would not have asserted that these quotations represented *merely* the views of individuals.

Who called into being this committee of physicians in Philadelphia, and who advised them? Who wrote the bill? It was legally unnecessary. It was needlessly offensive. It was thoroughly un-American. The men who did these things should ponder Dr. Woodward's well chosen words: "It would be unfortunate, indeed, if indiscreet utterances on the part of any one should hinder the movement. . . ." But if Dr. Woodward meant me, I do not think his remark fits. My warning has probably hastened the advance of the movement by bringing the matter well out into the open and by purging it (let us hope) of certain intolerable features.

Legislatures have to be watched. Witness the passage of a law in one of the States forbidding the teaching of evolution. If this be taken as an example of a response to a misguided majority, then my warning gains force. For we found that the number of physicans in Pennsylvania alone is about the same as the total number of chemists who are members of the largest association of chemists in the United States. Those of us who are not physicians must have ready other arguments than that of the wish of the majority when this matter comes into the several Legislatures. My warning note in your columns is certainly timely; it contains facts that will bear the closest scrutiny; and it is not intentionally offensive.

DAVID WILBUR HORN
Chairman, Committee on Legislation, Philadelphia Section of the American Chemical Society

QUOTATIONS

SCIENCE IN THE MAKING

AT Liverpool yesterday there came to an end a meeting of the British Association that will long be remembered as a definite stage in the making of knowledge. This annual congress of science has two chief functions—propaganda to the public and the advancement of knowledge. The face turned to the public was respectable enough. As usual, some of the more distinguished lights, and perhaps the greater part of the minor speakers, showed little talent for public speaking. They entangled themselves in the threads of their own arguments, like dancers in the colored ribbons of a carnival, turned their illustrations into obscurities, or took so long in saying that their time was too short that it left them time for little else. It is not ungracious to insist on a defect that could be remedied by taking pains; oratory is not required, but only a careful and orderly presentment of the subject such as most of the foreign guests, even those who had to grapple with an alien tongue, contrived to exhibit, in marked contrast with the body of our native speakers. There were, moreover, a few contributions that did not add to the dignity or to the effectiveness of the meeting. It may be difficult for a polite chairman to suppress speakers who are plainly in quest of self-advertisement, but there are committees with the function of accepting or rejecting proffered formal communications, and the council would do well to remind some of these of their duties. But in the proceedings generally there was more than sufficient to persuade laymen that science had a living spirit and was a high stimulus to the mind as well as a rich provider of material advantages. From these points of view the less formal addresses to members of the association and others in Liverpool and to citizens in adjacent towns deserved unusual commendation.

The internal work of the sections, the actual congress of those engaged in research, can not be judged by the public attention it received, perhaps, indeed, might be estimated more correctly in inverse proportion to the possibility of reporting it in a form of interest to the general reader. Even such sections as geography, anthropology, economic science, psychology, education and agriculture, apt to attract communications which sit uneasily in the category of science, also accomplished some useful work and gave real students the opportunity of distinguishing between opinion and knowledge. The geologists, ably led by their president, whose address was a model of

hard technical argument, discussed some of the difficult problems in stratigraphy and metamorphosis presented by local formations. The zoologists, amongst whom the presence of students and the younger generation of workers was notable, were also occupied chiefly with strictly technical matters, in which the conjunction of laboratory workers, museum systematists, and those who deal with living animals at sea or on land was very advantageous. In engineering also there was a useful collaboration of the "practical" and the theoretical sides, of the laboratory and the workshop. The physiologists made several concessions to publicity well justified by the contemporary importance of such subjects as diabetes and cancer, but they also had a valuable discussion with the chemists and physicists on the extremely important recent advances in knowledge of the physics of living membranes described by the chemical president in his address. By general agreement the proceedings in the section of botany were of unusual scientific value, although they were of a kind for the most part difficult for laymen.

But the meeting of 1923 owes its success above all to its achievements in physical science. On the borderland of chemistry and physics theories are pressing on each other concerning the material stuff of the universe. A single instance may serve to explain the general trend of the new knowledge. Although for long it has been suspected that the elements were built up of common units differing in number and arrangement, the fractional quantities assigned to them by the most careful observation seemed to forbid the existence of any simple relationship. Professor Soddy and his fellow-workers have now shown that the atomic weights are a mere statistical average, representing the proportions in which substances not hitherto suspected to have separate existences are found mingled in nature. The elements themselves are simple multiples of a common unit. And so in various ways older complexities are being resolved in what are at once higher and simpler unities. Chemical, physical, electrical and magnetic properties are all being reconciled as expressions or presentations of more fundamental properties of more elementary constituents of matter. Nature is turning out to be articulated, built of unit pieces, and these in their mass, size and movements are comparable with the phenomena of light, at present the ultimate and most nearly absolute standard of the universe. The vital interest of the proceedings at the Liverpool meeting of the British Association lay less in the announcement of completed results to the public than in the actual shaping of knowledge in an assemblage of leading physicists and chemists from almost every country in the world under the honored presidency of Sir Ernest Rutherford.—*The London Times.*

SCIENTIFIC BOOKS

Mathematics. By DAVID EUGENE SMITH. Marshall Jones Company, Boston, 1923, pp. x + 175.

THIS interesting little volume belongs to a series bearing the general title, "Our debt to Greece and Rome," edited by George Depue Hadzsits, University of Pennsylvania, and David Moore Robinson, Johns Hopkins University. An announcement appearing at the end of the volume gives 50 titles of the series together with the names of the authors in most cases. The present volume contains a brief introduction by T. L. Heath, who is well known on account of his extensive contributions to the history of Greek mathematics. Its four main divisions bear the following headings: Preliminary survey, the contributions in details, influence of the contributions, and conclusion.

The volume gives a very appreciative popular account of the mathematical contributions by the Greeks and the Romans, and brings out a number of historical facts which are not usually found in a history of mathematics. Hence, it will doubtless be read with profit by many mathematicians as well as by others to whom its popular style and very meager use of technical mathematics should appeal strongly. Mathematics has been called a Greek science, not only by those who find it difficult but also by those who are in position to understand its nature and who are familiar with the fundamental contributions of the Greeks along this line. It should, however, not be assumed that the Greeks developed the greater part of the mathematics of our times. They merely made a good start along certain important lines.

The reader who is mainly interested in actual facts relating to the contributions by the Greeks and Romans might sometimes wish that our author had not made such free use of the hyperbole. For instance, on page 90 we read: "In the first place we owe to the ancients our technical vocabulary, not merely that of mathematics in general and of notation in particular, but that of all the sciences"; while on page 160 we find the following sentence, "It is quite possible that our indebtedness in matters of notation and symbols is not great, and this should be frankly admitted." On page 114 we are told that Fermat was "the greatest genius of modern times in the theory of numbers," and on page 120 it is stated that "with respect to our indebtedness to Euclid, our modern text-books in mathematics are modeled primarily upon his works." This statement may profitably be compared with those relating to the modern tendency towards arithmetizing mathematics.

A question of a more serious nature may be raised as regards the mathematical contributions of the Romans. Our author emphasizes the fact that the Romans contributed practically nothing towards the

advancement of pure mathematics, but he seems to give them too much credit as regards applied mathematics when he speaks on page 12 and elsewhere of the Romans and the Greeks as complements of each other. In particular, the works of Archimedes and of Heron stand out more prominently in applied mathematics than those of any Roman authors, and the Greek work along the line of mathematical astronomy seems to be more important than that of the Romans along the line of land surveying. Our author makes it clear, however, that the Romans were not gifted as mathematicians and this is the main point in question in this connection.

In view of the fact that the author of the present volume is so widely and favorably known it is likely that many readers thereof will be inclined to place unusual confidence in the accuracy of the statements made therein. It seems, therefore, desirable to note here a few modifications and corrections which might otherwise appear uncalled for in such a brief review. Beginning with one of the most important cases we note that on page 137 there appears the following sentence: "It was Eratosthenes the mathematician who found the circumference of the earth to a degree of approximation not equaled by Ptolemy the astronomer, and, indeed, not equaled until modern times." On page 131 it is stated that this result was approximately 25,000 miles. By consulting volume 6 of the well-known *Encyklopädie der Mathematischen Wissenschaften* one finds on page 223 thereof that Posidonius, who was born 141 years later than Eratosthenes, had already obtained a somewhat more nearly accurate value for the circumference of the earth than the one due to Eratosthenes, and that the Arabians who made measurements by order of the caliph Almamun obtained in 827 a still closer approximation. Moreover, according to this authority, none of these results is very close to the truth, since even the best of them misses the actual value by more than 10 per cent.

On page 42 it is stated that Euclid used the term "even-times even numbers" for numbers of the form 2^n. The inaccuracy of this assertion can easily be established by consulting the well-known work entitled "The Thirteen Books of Euclid," by T. L. Heath. On page 282 of volume 2 thereof appears a discussion of Euclid's use of this particular term, and on page 419 of the same volume we find Euclid's proof of a theorem relating to numbers which are both even-times even and even-times odd. This proves definitely that Euclid used the term in question for a much larger class of numbers than those which are of the form 2^n.

On page 66 our author refers to the three different types of algebra noted by Nesselmann in 1842 and frequently quoted in the histories of mathematics; *viz.*, the rhetorical, the syncopated and the symbolic. He adds that "the first is, generally speaking, pre-Grecian, but extends through the classical period as well; the second is late Greek and medieval; the third is modern." On page 4 of volume 2 of Tropfke's *Geschichte der Elementar-Mathematik*, 1921, it is stated that the first of these three types of algebras is found among the Greeks up to the first century after Christ. This is in substantial agreement with the statement noted above, but Tropfke adds that the East Arabs, the Persians, the West Arabs up to the thirteenth century, the medieval mathematicians, such as Leonardo of Pisa, Jordanus Nemorarius and their pupils up to Regiomontanus (1436–1476) also employed this type of algebra. The Arabs avoided symbols to such an extent that they even used words in place of number symbols.

One of the striking features of the volume under review is the fact that the Greek contributions to algebra are given such a prominent position in comparison with those of the Arabs and the Hindus. In fact, on page 129 it is stated that the Arabs "added not a single proposition of importance, nor did they make any progress towards the solution of the cubic or biquadratic equation or towards the approximation of the roots of numerical equations of higher degree. They were translators, popularizers, and text-book writers, but they were not creative algebraists. As to the Hindus, they added nothing worthy of note to the stock of algebraic knowledge except in the way of a symbolism which no later writers adopted, and in the way of numerous interesting problems." These views are especially interesting, since the Hindus and the Arabs have frequently been incorrectly credited with the founding of algebra. The reviewer is, however, inclined to believe that the above quotation does not give enough credit to the Hindus and the Arabs as regards contributions towards the development of algebra.

On page 61 it is stated that the first text-book on conics is due to Apollonius of Perga. This is surprising in view of the fact that it is very well known that Euclid wrote four books on conics, which have been lost, and that Aristaeus wrote five books on the same subject, probably at a somewhat earlier date. It is also surprising to note that on page 37 our author speaks of the choice of the base of the sexagesimal system of numerical notation and of the division of the circle into 360 degrees as if we knew definitely the motives leading to these choices. Most mathematical historians seem to regard these as very difficult unsettled historical questions and various theories have been advanced from time to time to account for these particular choices. In view of the fact that the ancient Egyptians and Babylonians extracted the square root it is difficult to see why our

author says on page 101 "The operation of finding the square root of a number is distinctly Greek."

In closing, the reviewer desires to record one more surprise to himself when he read on page 77 that Diophantus "was searching in general for classes of numbers instead of particular numbers, and it is the class, as such, that is primarily sought in an indeterminate equation." It is well known that Diophantus usually gave only one solution even when the equation under consideration admitted an infinite number of solutions. Mathematical historians usually direct special attention to the fact that the Greeks were satisfied with one solution even in their geometric constructions. The reviewer never saw any evidence in support of the statement that Diophantus searched in general for classes of numbers in the solution of indeterminate equations.

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SPECIAL ARTICLES

POSITIVE ION CURRENTS FROM THE POSITIVE COLUMN OF MERCURY ARCS

A NEGATIVELY charged auxiliary electrode in the path of a mercury arc (as in a mercury rectifier) takes a current which is practically *independent of the impressed voltage* even if several hundred volts be employed. This current, which is usually a few milliamperes per cm², might conceivably be due either to emission of electrons from the electrode (as for example by photo-electric effect) or to positive ions taken up by the negative electrode. By placing in the ionized gas a negatively charged grid completely enclosing a positively charged electrode, it is found that the current to the positive electrode may remain nearly zero although the positive current of many milliamperes flows to the grid. This proves that the currents are due almost wholly to positive ions taken up by the negative electrode, since electrons from the grid would pass to the positive electrode.

Why are these positive ion currents so nearly independent of the voltage? The explanation seems comparatively simple and is in excellent accord with experiment.

Electrons are repelled from the negative electrode while positive ions are drawn towards it. Around each negative electrode there is thus a *sheath* of definite thickness containing only positive ions and neutral atoms. The thickness of this sheath can be calculated from the space charge equations used for pure electron discharges. Since mercury ions are 200×1848 times heavier than electrons, the currents carried with equal voltage will be $\sqrt{200 \times 1848}$ or 608 times smaller.

Thus X the thickness (in cm.) of the sheath in the case of a plane electrode receiving positive mercury ions with a current density i/A, (amperes per cm²) can be calculated from the equation[1]

$$\frac{i}{A} = \frac{2.33 \times 10^{-6}}{608} \frac{V^{3/2}}{X^2}$$

where V is the potential of the electrode with respect to the surrounding gas. With a current density of ten milliamperes per cm² the thickness of the sheath is thus only 0.02 cm with 100 volts on the electrode; and 0.0035 cm with 10 volts.

Electrons are reflected from the outside surface of the sheath while all *positive* ions which reach the sheath are attracted to the electrode. A change in the negative voltage of the electrode from 10 to 100 volts thus only changes the sheath thickness from 0.0035 up to 0.02 cm and since this displacement of the edge of the sheath is small compared to the free path of the electrons or ions, and the dimensions of the tube, it follows directly that no change occurs in the positive ion current reaching the electrode. The electrode is in fact perfectly screened from the discharge by the positive ion sheath, and its potential can not influence the phenomena occurring in the arc, nor the current flowing to the electrode.

With cylindrical electrodes of diameters comparable with the thickness of the sheath, the variation of the sheath diameter with the voltage causes the effective collecting area for the ions to change so that the currents are not strictly independent of the voltage. This conclusion affords a crucial test of the correctness of the theory, especially since electron emission would follow entirely different laws. The positive ion current flowing to the electrode should be proportional to the area of the outside of the sheath, or in other words to its diameter. This can be calculated by means of the space charge equation for concentric cylinders. For positive mercury ions this becomes

$$\frac{i}{L} = \frac{14.69 \times 10^{-6}}{608} \frac{V^{3/2}}{r\beta^2}$$

where L is the length and r is the radius of the cylindrical electrode and β is a function of a/r where a is the radius of the outside of the sheath. The method of calculating this function has been given[2] and a table of its value as a function of a/r will appear in a forthcoming number of the *Physical Review*.

The experimental data have confirmed the theory by showing that a small diameter of the collecting electrodes and low intensities of ionization cause an increased variation of current with voltage, both of these factors tending to make the sheath diameter large compared to the electrode diameter.

The following typical experimental data were ob-

[1] Langmuir, *Phys. Rev.*, 2, 450 (1913).

[2] Langmuir, *l.c.*

tained with a glow discharge in mercury vapor using a hot tungsten cathode emitting 30 milliamperes. The conditions were such as to give a rather weak ionization, but the results are quite comparable with those observed in the portions of a mercury arc tube where similar ionization occurs.

ELECTRODE RADIUS 0.0635 CM. LENGTH 6.2 CM.

Volts	I obs. m.a.	β	$\frac{a}{r}$	I cal. m.a.
40	0.31	1.40	2.58	0.308
60	0.36	1.77	3.06	0.366
80	0.40	2.05	3.43	0.410
100	0.46	2.26	3.72	0.443
140	0.52	2.74	4.39	0.524

The last column gives currents calculated on the assumption that they are proportional to the values of a/r in the 4th column as they should be by the theory. It is seen that the agreement with the currents in the 2nd column is within the probable experimental error.

The positive ion currents flowing into the sheath in this case correspond to a current density of 49 microamperes per cm². With the more intense ionization in a five-ampere mercury arc rectifier, positive ion current densities of about 30–60 milliamperes per cm² are obtained and these currents, because of the small thickness of the sheath, are much more nearly independent of the voltage even if the electrodes are of small diameter.

This theory, for reasons which can not well be stated in a brief note, leads to the following conception of the positive column of the mercury arc (and of glow discharges in general).

The glass walls of the discharge tube become negatively charged and repel (or reflect) all but a very minute fraction of the electrons that move towards the walls. Since electrons in general make elastic collisions with mercury atoms, the motion of the electrons is in random directions, almost as many electrons moving against the potential gradient in the arc, as with it. Thus an apparent current density of one ampere per cm² in an arc is to be regarded as consisting of an electron current of perhaps 20 amperes per cm² in one direction and a similar current of 19 amperes per cm² in the opposite direction. The positive ion currents, because of the large mass of the ions, are many hundreds of times smaller (10 to 60 milliamperes per cm²). The positive ions, in general, lose a great part of their energy in each collision with the atoms, and thus behave as though all collisions were inelastic.

Few, if any, of the ions move against the potential gradient, but by collisions with atoms they are thrown against the glass walls before having travelled more than one or two free paths, these paths usually being comparable with the diameter of the discharge tube. Enough electrons pass to the walls to neutralize the charges of the positive ions and in doing so liberate in the form of heat, an energy corresponding to the ionizing potential 10.4 volts. Thus a positive ion current density of 10 milliamperes per cm² generates a heat of over 0.1 watt per cm². This accounts for the influences of the size of the tube on the voltage drop in the arc.

A more complete discussion of these conclusions will be published in the November number of the G. E. Review.

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LATE FERTILIZATION AND SEX-RATIO IN TROUT

THE experiments of R. Hertwig[1] and his pupils have shown conclusively that delayed fertilization in frogs will produce a preponderance of males, in some cultures 99–100 per cent. males being produced. It occurred to me that the trout would afford favorable material for seeing whether this phenomenon could be reproduced in other species. Accordingly, in 1921 and 1922, by the courtesy of the Midlands Fisheries Ltd., and in especial of their manager at Nailsworth, Glos., Mr. Stevens, I carried out some experiments on the matter.

I since discovered that Dr. Mrsic, in Professor Hertwig's laboratory at Munich, had also been working at the subject and had obtained more definite results than I. He had kindly sent me the proofs of his article due to appear shortly in the *Arch. Ent. Mech.*,[2] and allowed me to mention his results.

My own results were as follows:

	Total	Per cent. ♂♂	P.E.
Control '21	119	47.90	± 3.09
Control '22	274	48.17	± 2.04
Late-fertilized '21 (some 4, some 7 days late)	332	54.52	± 1.83
Early-fertilized '22 (7 days early)	319	50.78	± 1.89

Dr. Mrsic's were as under (I have calculated the probable errors for his figures, as these do not appear in his paper):

Control (I)	90	47.8	± 3.55
4 days—7 days late (II–III)	199	39.7	± 2.34
13 days late (IV)	77	50.6	± 3.84
21 days late (V)	57	66.7	± 4.21

[1] Hertwig, R., '05–'07, Verh. Dtsch. Zool. Ges.: '12, Biol. Zentr. 32; '21, Sitzb. Bayr. Ak. Wiss. 1921; Kuschakewitsch, '10, Festschr. f. R. Hertwig, 1910.

[2] Since published while the above was passing through the press.